

Congress of the United States
Washington, DC 20515

March 15, 2011

The Honorable Greg Jaczko
Chairman
Nuclear Regulatory Commission
11555 Rockville Pike
Rockville, MD 20852

Dear Chairman Jaczko:

We write to request additional information related to the seismic safety features that are included in nuclear reactors currently in operation in this country. We are concerned that these reactors may not have the features necessary to withstand the sort of catastrophic earthquake and tsunami that has crippled several reactors in Japan, and caused a meltdown and the release of the highly radioactive materials contained within them.

The 9.0 magnitude earthquake caused a number of Japan's nuclear reactors to shut down automatically. However, a combination of tsunami-related damage and the long duration of the external power outages have subsequently led some of these reactors' emergency diesel generators, and thus cooling systems, to fail. To reduce rising pressure inside the Fukushima reactors, radioactive vapor is being vented, but three explosions have occurred as these pressures grew too high.¹ It appears as though meltdowns are proceeding at these reactors. Now life-threatening levels of radiation are being emitted, a 19-mile evacuation and no-fly zone has been established, a fire at a spent fuel pool at one of the units occurred, and 1,350 of the plant's 1,450 workers have been evacuated. Radioactive materials such as cesium and iodine have been detected as much as 100 miles away from these reactors.²

According to analysis prepared by Rep. Markey (see Appendix A, the map appended to this letter), there are eight nuclear reactors located on the seismically active West Coast of the United States, and twenty-seven nuclear reactors located near the New Madrid fault line in the Midwest.³ There are additionally thirty-one nuclear reactors in

¹ http://www.washingtonpost.com/business/economy/nuclear-crisis-deepens-as-third-reactor-loses-cooling-capacity/2011/03/14/ABk6rQV_story.html

² http://www.msnbc.msn.com/id/42066534/ns/world_news-asia-pacific/

³ See <http://pubs.usgs.gov/fs/2009/3071/pdf/FS09-3071.pdf> In 1811–1812, three major earthquakes (magnitude 7 to 7.7 on the commonly used Richter Scale) occurred near the town of New Madrid, MO. In 1886, a large earthquake (Richter Scale magnitude of about 7) occurred near Charleston, S.C. The United States Geological Survey has estimated that the chance of having an earthquake similar to one of the 1811–12 sequence in the next 50 years is about 7 to 10 percent, and the chance of having a magnitude 6 or larger earthquake in 50 years is 25 to 40 percent.

the United States that are of the same Mark 1 or Mark 2 design as those currently imperiled in Japan, and twelve of these are located in seismically active zones.

The Nuclear Regulatory Commission (NRC)⁴ indicates that safety-significant structures, systems, and components of nuclear reactors must be designed to take into account:

- “the most severe natural phenomena historically reported for the site and surrounding area. The NRC then adds a margin for error to account for the historical data’s limited accuracy;
- appropriate combinations of the effects of normal and accident conditions with the effects of the natural phenomena; and
- the importance of the safety functions to be performed.”

According to its website⁵, the San Onofre nuclear power plant, which is located 45 miles from Long Beach, California, is designed to withstand a 7.0 magnitude earthquake. An NRC staff memo⁶ indicates that the Diablo Canyon nuclear power plant, which is located 12 miles from San Luis Obispo, California, is designed to withstand a 7.5 magnitude earthquake. But according to the Southern California Earthquake Center,⁷ there is an 82 percent probability of an earthquake of 7.0 magnitude occurring in the next 30 years, and a 37 percent probability that an earthquake of 7.5 magnitude will occur.

It is not just resilience to the direct effects of an earthquake that raises concerns. While all nuclear power plants are equipped with emergency diesel generators, it is clear from the Japanese catastrophe that these are not themselves infallible, since they all appear to have failed at the Fukushima reactors. These can also fail for other reasons. For example, in 1990,⁸ the Vogtle plant in Georgia experienced a station blackout when a truck knocked over a transmission pole in the switchyard causing a loss of offsite power. The emergency diesel generator started but failed to load. The power plant suffered a complete station blackout, but fortunately power was restored in just over half an hour. NRC regulations only require nuclear power plants to be able to sustain cooling function in a station blackout for 4-8 hours⁹ using back-up battery powered generation capacity.

The vulnerability to the effects of a total station blackout was also noted by the NRC in its 2003 report entitled “Regulatory Effectiveness of the Station Blackout

⁴ <http://www.nrc.gov/reading-rm/doc-collections/fact-sheets/fs-seismic-issues.html>

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<http://www.sce.com/PowerandEnvironment/PowerGeneration/SanOnofreNuclearGeneratingStation/publicsafety.htm>

⁶ Research Information Letter 09-001: Preliminary Deterministic Analysis of Seismic Hazard at Diablo Canyon Nuclear Power Plant from Newly Identified “Shoreline Fault”

⁷ <http://www.scec.org/core/public/scecontext.php/3935/13662>

⁸ <http://query.nytimes.com/gst/fullpage.html?res=9C0CEEDF123AF932A35757C0A966958260>

⁹

http://adamswebsearch2.nrc.gov/idmws/DocContent.dll?library=PU_ADAMS^pbntad01&LogonID=ba229e2ba98e61e668d07a5da3c0e726&id=032520158

Rule.”¹⁰ Appendix B of this report (attached to this letter) provides reactor-specific information related to outages experienced, demonstrating that many nuclear reactors in this country have already experienced lengthy power outages. The second column in this table reports the overall risk of core damage frequency as calculated by the plant owners. The third column reports the risk of core damage due to complete station blackout as calculated by the plant owners, which is also expressed as a percentage in column 4. If emergency diesel generators were truly fully reliable, there would be no risk associated with a complete station blackout. Instead, many nuclear reactors are estimated to have a real risk of core damage due to a complete station blackout. The fifth column in this table shows four parameters. The first parameter is the battery coping duration in hours, which can easily be seen to be four hours for most reactors, so some reactors can operate on batteries for eight hours.

Clearly, the risks of core damage to reactors due to a complete power outage are non-trivial and have already been contemplated by the NRC. The 4-8 hour battery generation capacity currently in place at U.S. reactor sites would not have helped mitigate the effects of the Japanese earthquake and subsequent tsunami.

Finally, the spent fuel pools at these nuclear reactors can also fail. If the water that cools these fuel rods drains, the zirconium cladding them can catch fire and lead to another source of melting fuel that can spew high level radioactive materials into the environment. This appears to have already occurred in Japan.

We are concerned that San Onofre, Diablo Canyon, and possibly other nuclear reactors located in seismically active areas are not designed with sufficient levels of resiliency against the sort of earthquakes scientists predict they could experience. We are also interested in more detailed information about just what it means to take the “most severe natural phenomena historically reported for the site and surrounding area” into account when designing the safety related features of nuclear reactors. Consequently, we ask for your prompt response to the following questions and requests for information.

- 1) Please provide the Richter or moment magnitude scale rating for each operating nuclear reactor in the United States. If no such rating information exists, then on what basis can such an assertion be made regarding the design of any single nuclear power plant?
- 2) The San Onofre reactor is reportedly designed to withstand a 7.0 earthquake, and the Diablo Canyon reactor is designed to withstand a 7.5 earthquake. According to the Southern California Earthquake Center,¹¹ there is an 82 percent probability of an earthquake of 7.0 magnitude in the next 30 years, and a 37 percent probability that an earthquake of 7.5 magnitude will occur. Shouldn't these reactors be retrofitted to ensure that they can withstand a stronger earthquake than a 7.5? If not, why not?
- 3) Please provide specific information regarding the differences in safety-significant structures between a nuclear power plant that is located in a seismically active area and one that is not. Please provide, for each operating nuclear reactor in a seismically

¹⁰ See <http://www.nrc.gov/reading-rm/doc-collections/nuregs/staff/sr1776/sr1776.pdf>

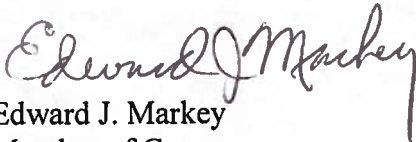
¹¹ <http://www.scec.org/core/public/scecontext.php/3935/13662>

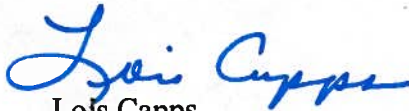
active area, a full list and description of the safety-significant design features that are included that are not included in similar models that are not located in seismically active areas.

- 4) Please fully describe the emergency back-up power requirements that operating nuclear power plants must possess. How long are emergency diesel generators and back-up battery-powered generators required to be able to operate? If different requirements exist for different locations in the United States or for different types of reactors, please also include this information in your response.
- 5) For each operating nuclear power plant, please indicate a) whether the spent fuel pools are located inside or out of the containment structure, b) whether the emergency diesel generators are connected to the cooling and other equipment associated with the spent fuel pools, c) whether the battery-powered generators are connected to the cooling and other equipment associated with the spent fuel pools.
- 6) Please provide a list of all incidents at operating nuclear reactors since 1990 that have involved a) the loss of off-site power, b) a station blackout, or c) a failure of the battery-powered generators at the reactor. For each such incident, please fully describe the circumstances and duration, and impacts or damages, if any.
- 7) In your opinion, can any of the operating nuclear reactors in the United States withstand an earthquake of the magnitude experienced in Japan?

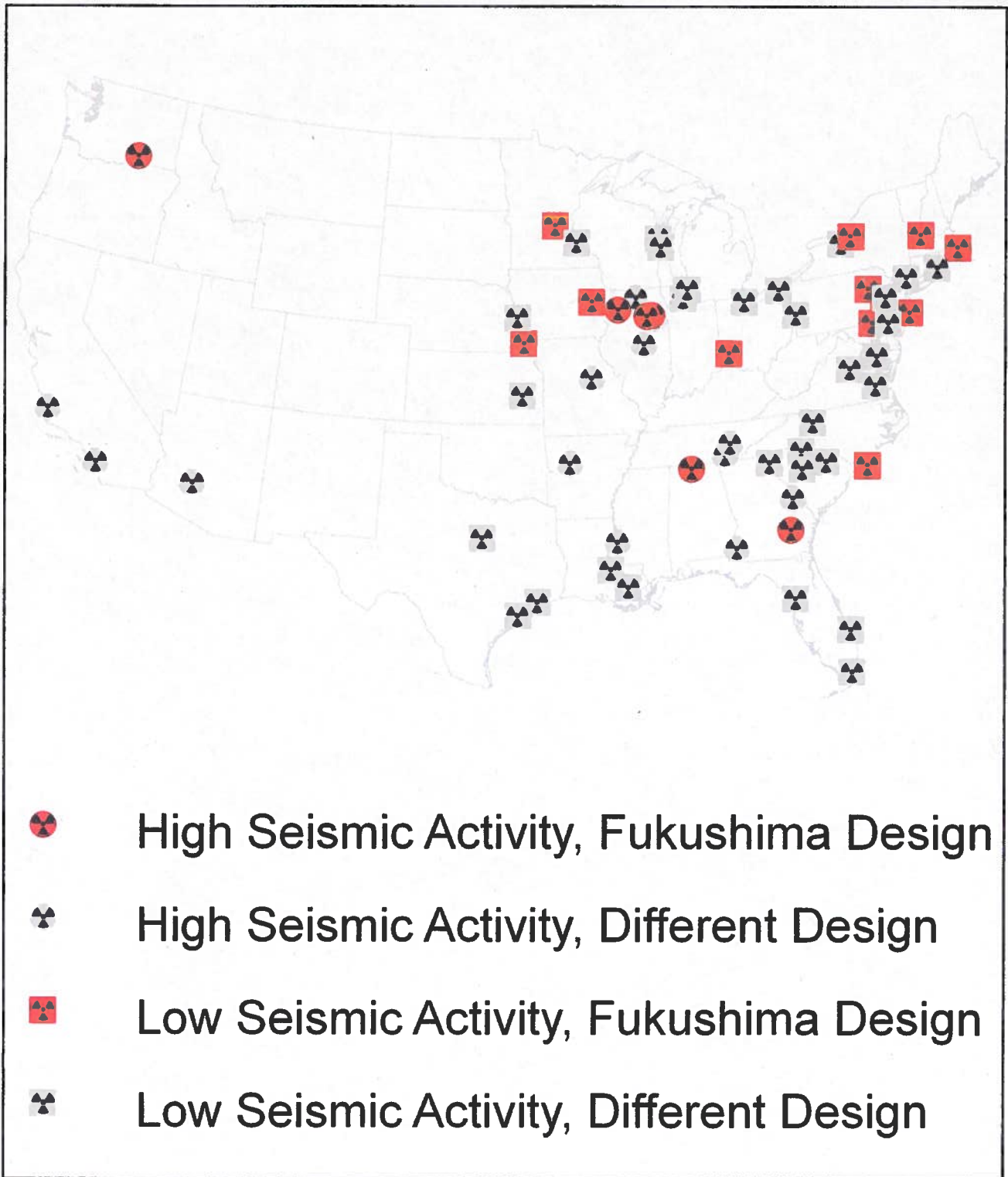
Please provide your response no later than close of business on Friday April 8, 2011. If you have any questions or concerns, please have your staff contact Dr. Michal Freedhoff of the Natural Resources Committee staff or Dr. Ilya Fischhoff of Rep. Markey's staff at 202-225-2836 or Jonathan Levenshus of Rep. Capps' staff at 202-225-3601.

Sincerely,


Edward J. Markey
Member of Congress


Lois Capps
Member of Congress

APPENDIX A



APPENDIX B

Plant-Specific Station Blackout Information by Reactor Type and Operating Status

Table B-1 Operating pressurized-water reactors

Plant	Plant CDF	SBO CDF	Percent SBO CDF of Plant CDF	Coping time in hours/EDG reliability/Aac access time in minutes/ extremely severe weather	Modification summary including dc load shed procedural modifications	SBO factors				
						PRA LOOP initiating event frequency	Number of LOOP events at power since commercial operation			LOOP event recovery times > 240 minutes
							Plant	Weather	Grid	Power
Arkansas Nuclear One Unit 1	4.67E-05	1.58E-05	33.8	4/95/10/1	Added 1 DG and crosstie	3.58E-02	2	1		
Arkansas Nuclear One Unit 2	3.40E-05	1.23E-06	3.6	4/95/10/1	Added crosstie	5.84E-02	1	1		
Beaver Valley Unit 1	2.14E-04	6.51E-05	30.4	4/975/60/1	Added crosstie	6.64E-02	2			
Beaver Valley Unit 2	1.92E-04	4.86E-05	25.3	4/975/60/1	Added crosstie	7.44E-02	1			
Braidwood Units 1&2	2.74E-05	6.20E-06	22.6	4/95/10/1		4.53E-02	2			
Bryon Units 1&2	3.09E-05	4.30E-06	13.9	4/95/10/1		4.43E-02				
Callaway	5.85E-05	1.80E-05	30.8	4/975/-/1		4.60E-02				
Calvert Cliffs Units 1&2	2.40E-04	8.32E-06	3.4	4/975/60/4	Added 1 EDG and one 1 DG	1.36E-01	3			
Catawba Units 1&2	5.80E-05	6.0E-07	10.3	4/95/10/1		2.0E-03	1			330
Comanche Peak Units 1&2	5.72E-05	1.5E-05	26.2	4/95/-/1						

Plant-Specific Station Blackout Information by Reactor Type and Operating Status

Table B-1 Operating pressurized-water reactors (Cont.)

Plant	Plant CDF	SBO CDF	Percent SBO CDF of Plant CDF	Coping time in hours/EDG reliability/Aac access time in minutes/ extremely severe weather	Modification summary including dc load shed procedural modifications	SBO factors					
						PRA LOOP initiating event frequency	Number of LOOP events at power since commercial operation			LOOP event recovery times ≥ 240 minutes	
							Plant	Weather	Grid		Power
Crystal River Unit 3	1.53E-05	3.28E-06	21.5	4/.975/-/4	dc load shed. Added nonclass 1E battery	4.35E-01	3				
Davis-Besse	6.6E-05	3.50E-05	53	4/.95/10/2	Added 1 DG	3.50E-02	2	1		1680	
DC Cook Units 1&2	6.2E-05	1.13E-05	18.1	4/.975/-/2	dc load shed	4.0E-02	1				
Diablo Canyon Units 1&2	8.8E-05	5.0E-06	5.68	4/.95/-/1	Added 1 DG	9.1E-02	1				261 917
Farley Units 1&2	1.3E-04	1.22E-05	9.4	4/.95/10/3	Service water to Aac, auto load shedding	4.70E-02	2				
Fort Calhoun	1.36E-05	NA	–	4/.95/-/2	DC load shed	2.17E-01	2				
Ginna	8.74E-05	1.0E-06	1.14	4/.975/-/1		3.50E-03	4				
Harris	7.0E-05	1.71E-05	24.4	4/.95/-/3	Lighting in several areas, ladder to isolation valve						
Indian Point Unit 2	3.13E-05	4.47E-06	14.3	8/.95/60/2	Added a DG for gas turbine auxiliaries	6.91E-02	2		3	390	

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Table B-1 Operating pressurized-water reactors (Cont.)

Plant	Plant CDF	SBO CDF	Percent SBO CDF of Plant CDF	Coping time in hours/EDG reliability/Aac access time in minutes/ extremely severe weather	Modification summary including dc load shed procedural modifications	SBO factors				
						PRA LOOP initiating event frequency	Number of LOOP events at power since commercial operation			LOOP event recovery times ≥ 240 minutes
							Plant	Weather	Grid	Power
Indian Point Unit 3	4.40E-05	4.80E-06	10.9	8/ 95/60/2		6.80E-02	1			
Kewaunee	6.6E-05	2.64E-05	40	4/ 95/60/2	Cross-tie to nonsafety power source	4.4E-02				
McGuire Units 1&2	4.0E-05	9.26E-06	23.3	4/ 95/10/1		7.0E-02	3			
Millstone Unit 2	3.42E-05	1.0E-10	NMN	8/ 975/60/5	Upgraded unit 1-2 crosstie	9.10E-02	1	1		330
Millstone Unit 3	5.61E-05	5.10E-06	6	8/ 975/60/5	Added DG	1.12E-01				
North Anna Units 1&2	7.16E-05	8.0E-06	11.2	4/ 95/60/4	Added DG, switchgear, crosstie	1.14E-02				
Oconee Units 1, 2&3	2.3E-05	2.57E-06	11.2	4/ 975/10/1		9.0E-02	2			
Palisades	5.07E-05	9.10E-06	17.9	4/ 95/-/1	DC load shed, compressed air for ADVs	3.0E-02	3			388
Palo Verde Units 1, 2&3	9.0E-05	1.91E-05	21.2	4/ 95/10/2	Added 2 gas turbines	7.83E-02	3			1138
Point Beach Units 1&2	1.15E-04	1.51E-05	13.1	4/ 975/60/2	Gas turbine modifications	6.10E-02	4			

Plant-Specific Station Blackout Information by Reactor Type and Operating Status

Table B-1 Operating pressurized-water reactors (Cont.)

Plant	Plant CDF	SBO CDF	Percent SBO CDF of Plant CDF	Coping time in hours/EDG reliability/Aac access time in minutes/ extremely severe weather	Modification summary including dc load shed procedural modifications	SBO factors				
						PRA LOOP initiating event frequency	Number of LOOP events at power since commercial operation			LOOP event recovery times ≥ 240 minutes
							Plant	Weather	Grid	
Prairie Island Units 1&2	5.05E-05	3.1E-06	6.14	4/975/10/3	Added 2 EDGs	-	1	2		296 296
Robinson Unit 2	3.20E-04	2.6E-05	8.13	8/95/60/4	Modified conduit supports in switchgear room	6.1E-02	2			454
Salem Unit 1	5.20E-05	2.10E-05	40.4	4/975/-/2	EDG compressed air mod	6.0E-02	1			
Salem Unit 2	5.5E-05	1.70E-05	30.9	4/975/-/2	EDG compressed air mod	6.0E-02	2			655 1675
San Onofre Units 2&3	3.0E-05	2.0E-06	6.67	4/95/-/1	DC load shed and crosstie	1.1E-01			2	
St. Lucie Unit 1	2.30E-05	2.65E-06	11.5	4/975/10/5	Added crosstie	1.5E-01	1		3	
St. Lucie Unit 2	2.62E-05	2.64E-06	10.1	4/975/10/5	Added crosstie	1.5E-01				
Seabrook	6.86E-05	1.53E-05	22.3	4/975/-/3	DC load shed	4.93E-02				
Sequoyah Units 1&2	1.70E-04	5.32E-06	3.2	4/975/-/2	DC load shed, added air supply	5.16E-03	2			

Plant-Specific Station Blackout Information by Reactor Type and Operating Status

Table B-1 Operating pressurized-water reactors (Cont.)

Plant	Plant CDF	SBO CDF	Percent SBO CDF of Plant CDF	Coping time in hours/EDG reliability/Aac access time in minutes/ extremely severe weather	Modification summary including dc load shed procedural modifications	SBO factors				
						PRA LOOP initiating event frequency	Number of LOOP events at power since commercial operation			LOOP event recovery times \geq 240 minutes
							Plant	Weather	Grid	Power
Summer	2.0E-04	4.9E-05	24.5	4/95/-/3	DC load shed, battery mod	7.3E-02			1	
South Texas Units 1&2	4.3E-05	1.46E-05	34.9	4/975/10/5	Procedural cross-tie					
Surry Units 1&2	1.25E-04	8.09E-06	6.47	4/975/10/4	Added DG	7.69E-02				
Three Mile Island Unit 1	4.49E-04	1.57E-05	3.5	4/975/10/3	Modifications to existing DGs	5.68E-02				
Turkey Point Units 3&4	3.73E-04	4.70E-06	1.2	8/95/10/5	Added 2 EDGs and cross-tie	1.7E-01	4	2	7	7950 7908
Vogtle Units 1&2	4.9E-05	4.4E-07	11	4/95/-/2	Added 5 circuit breakers and lighting	6.6E-04				
Waterford Unit 3	1.80E-05	6.24E-06	34.7	4/975/-/4	DC load shed. Added portable air compressors for EDGs	3.6E-02				
Watts Bar Unit 1	8.0E-05	1.73E-05	21.6	4/975/-?/1		3.64E-02				
Wolf Creek	4.2E-05	1.88E-05	44.8	4/95/-/1		5.12E-02				

Plant-Specific Station Blackout Information by Reactor Type and Operating Status

Table B-2 Operating boiling-water reactors

Plant	Plant CDF	SBO CDF	Percent SBO CDF of Plant CDF	Coping time in hours/EDG reliability/Aac access time in minutes/ extremely severe weather	Modification summary including dc load shed procedural modifications	SBO factors				
						PRA LOOP initiating event frequency	Number of LOOP events at power since commercial operation			
							Plant	Weather	Grid	Power
Browns Ferry Units 2&3	4.80E-05	1.30E-05	27	4/.95/-/1	dc load shed	1.12E-01				
Brunswick Units 1&2	2.70E-05	1.80E-05	66.7	4/.975/60/5	Modified controls for existing crosstie	7.40E-02	3			1508 814
Clinton	2.66E-05	9.8E-06	36.8	4/.95/10/1	Added gas fans for selected room cooling	8.40E-02				
Cooper	7.97E-05	2.77E-05	34.8	4/.95/-/2		3.50E-02				
Dresden Units 2&3	1.8E-05	9.30E-07	5.03	4/.95/60/2	Added 2 DGs	1.12E-01	3	1		240
Duane Arnold	7.84E-06	1.90E-06	24.2	4/.975/-/2	dc load shed, RCIC insulation & main control room lighting	1.17E-01			1	
Fermi	5.70E-06	1.3E-07	NMN	4/.95/60/1		1.88E-01				
FitzPatrick	1.92E-06	1.75E-06	NMN	4/.95/-/1	dc load shed, instrumentation and power supply mods	5.70E-02				
Grand Gulf	1.77E-05	7.46E-06	36.8	4/.95/-/2	dc load shed	6.80E-02				

Plant-Specific Station Blackout Information by Reactor Type and Operating Status

Table B-2 Operating boiling-water reactors (Cont.)

Plant	Plant CDF	SBO CDF	Percent SBO CDF of Plant CDF	Coping time in hours/EDG reliability/Aac access time in minutes/ extremely severe weather	Modification summary including dc load shed procedural modifications	SBO factors				
						PRA LOOP initiating event frequency	Number of LOOP events at power since commercial operation			LOOP event recovery times \geq 240 minutes
							Plant	Weather	Grid	
Hatch Unit 1	2.23E-05	3.30E-06	14.8	4/ 95/60/2	Replaced battery chargers	2.20E-02				
Hatch Unit 2	2.36E-05	3.23E-06	13.7	4/ 95/60/2	Replaced battery chargers	2.20E-02				
Hope Creek	4.63E-05	3.38E-05	73	4/ 95/-/2	Valve modifications	3.4E-02				
LaSalle Units 1&2	4.74E-05	3.82E-05	80.6	4/ 975/-/1	dc load shed, New batteries	9.60E-02	1			
Limerick Units 1&2	4.30E-06	1.0E-07	NMN	4/ 95/60/3	Upgraded cross-ties	5.9E-02				
Monticello	2.60E-05	1.20E-05	46.2	4/ 95/-/1	dc load shed	7.90E-02				
Nine Mile Point Unit 1	5.50E-06	3.50E-06	NMN	4/ 975/-/1	dc load shed, added two safety related batteries	5.00E-02	4			595
Nine Mile Point Unit 2	3.10E-05	5.50E-06	17.7	4/ 975/-/1	dc load shed	1.20E-01				

Plant-Specific Station Blackout Information by Reactor Type and Operating Status

Table B-2 Operating boiling-water reactors (Cont.)

Plant	Plant CDF	SBO CDF	Percent SBO CDF of Plant CDF	Coping time in hours/EDG reliability/Aac access time in minutes/ extremely severe weather	Modification summary including dc load shed procedural modifications	SBO factors					
						PRA LOOP initiating event frequency	Number of LOOP events at power since commercial operation			LOOP event recovery times \geq 240 minutes	
							Plant	Weather	Grid		Power
Oyster Creek	3.90E-06	2.30E-06	NMN	4/.975/60/1	Added crosstie & reactor pressure indication	3.26E-02	3				240
Peach Bottom Units 2 & 3	5.53E-06	4.81E-07	8.7	8/.975/60/3	Cross-tie to hydro unit	5.9E-02					
Perry	1.30E-05	2.25E-06	43.4	4/.95/10/1	Replaced selected cables	6.09E-02					
Pilgrim	5.80E-05	1.0E-10	NMN	8/.975/10/4	Alarms to line-up Aac	6.17E-01	1	5			1263 534
Quad Cities Units 1&2	1.2E-06	5.72E-07	NMN	4/.95/60/1	Added 2 DGs	4.81E-02	2				
River Bend	1.55E-05	1.35E-05	87.5	4/.95/-/2	Minor structural mod	3.50E-02	1				
Susquehanna Units 1&2	1.7E-05	4.2E-11	NMN	4/.975/-/2	dc load shed	-	1				
Vermont Yankee	4.30E-06	9.17E-07	21.3	8/.975/10/4	Modified incoming line and controls	1.0E-01	2			277	
Washington Nuclear Plant Unit 2	1.73E-05	1.07E-05	61.1	4/.95/-/1	dc load shed, replaced inverters	2.46E-02					